January 1998

Science 30

Grade 12 Diploma Examination

Alberta
EDUCATION

January 1998

Science 30

Grade 12 Diploma Examination

Description

Time: 2.5 h. You may take an additional 0.5 h to complete the examination.

This is a **closed-book** examination consisting of

- 44 multiple-choice and 12 numerical-response questions of equal value, worth 70% of the examination
- 2 written-response questions, each worth 15% of the examination

This examination contains sets of related questions.

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

A science data booklet is provided for your reference.

The perforated pages at the back of this booklet may be torn out and used for your rough work. No marks will be given for work done on the tear-out pages.

Instructions

- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- You are expected to provide your own scientific calculator.
- Use only an HB pencil for the machine-scored answer sheet.
- If you wish to change an answer, erase **all** traces of your first answer.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- Read each question carefully.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

A. science
B. biology
C. physics
D. chemistry

Answer Sheet

● Ⓑ Ⓒ Ⓓ

Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- **Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

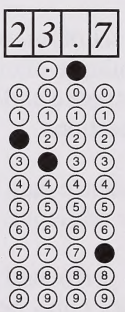
Examples

Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is _____.
(Record your answer to three digits on the answer sheet.)

Average = (21.0 + 25.5 + 24.5)/3
= 23.666
= 23.7 (rounded to three digits)

Record 23.7 on the answer sheet →



Correct-Order Question and Solution

When the following subjects are arranged in alphabetical order, the order is _____. (Record all four digits on the answer sheet.)

1 physics
2 chemistry
3 biology
4 science

Answer 3214

Record 3214 on the answer sheet →

Written Response

- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must be well organized and address **all** the main points of the question.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and explicit.
- Descriptions and/or explanations of concepts must be correct and reflect pertinent ideas, calculations, and formulas.
- Your answers **should be** presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.

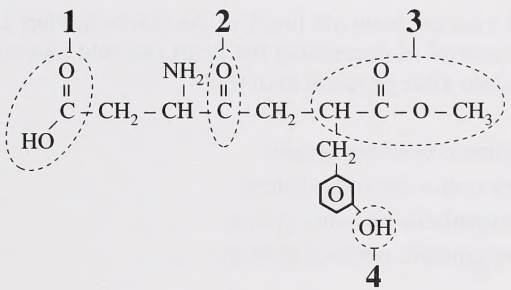
The principles of science are important in the operation and use of a cafeteria.

1. A customer in a cafeteria drank a number of cans of soda pop. Despite the acidity of the pop, the pH of her body fluids remained constant because her body responded by

A. exhaling oxygen
B. releasing $H_3O^+_{(aq)}$ into the blood
C. neutralizing the acid in the stomach
D. buffering the acid absorbed into the blood

Use the following information to answer the next question.

The Structural Formula for a Substance Similar to Aspartame



Numerical Response

1. The soda pop was artificially sweetened with aspartame. Match the number of the functional group shown above with the corresponding chemical family given below.

Alcohol	_____	(Record your answer in the first column on the answer sheet.)
Ester	_____	(Record your answer in the second column on the answer sheet.)
Organic acid	_____	(Record your answer in the third column on the answer sheet.)
Ketone	_____	(Record your answer in the fourth column on the answer sheet.)

2. Vinegar (5% by volume $CH_3COOH_{(aq)}$) is a food additive in ketchup and salad dressings. Vinegar is **best** classified as a

A. dilute weak acid
B. dilute strong acid
C. concentrated weak acid
D. concentrated strong acid

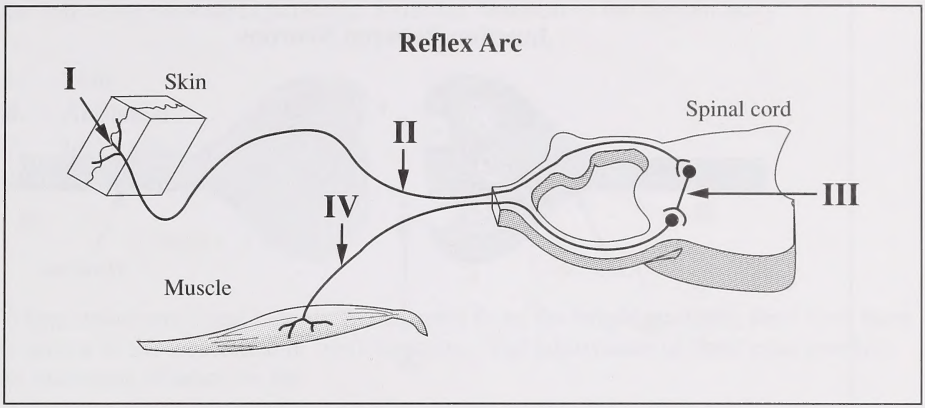
3. Lamps keep food warm in the cafeteria by emitting radiation with a frequency of 10^{13} Hz. This type of radiation is

A. infrared
B. ultraviolet
C. shortwave
D. microwave

4. Members of a soccer team ate lunch at the cafeteria after a game. Which body system is in control of decreasing the heart rate and increasing the activity of the digestive system after physical activity?

A. Sympathetic nervous system
B. Sensory motor nervous system
C. Parasympathetic nervous system
D. Sensory somatic nervous system

Use the following information to answer the next question.

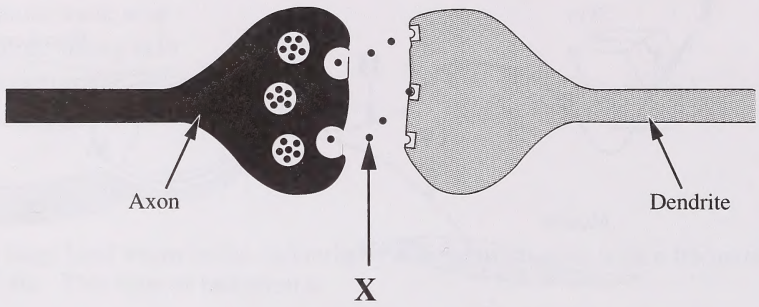


5. When an employee's hand came very close to a hot burner, he immediately pulled it away through reflex action. The part of the reflex arc that coordinates the sensory input with the motor response is labelled

A. I
B. II
C. III
D. IV

Use the following information to answer the next question.

Junction Between Neurons



6. In order for an impulse to travel through a reflex arc, it must pass from one neuron to another. The substance labelled **X most likely** represents

A. sodium ions
B. acetylcholine
C. cholinesterase
D. potassium ions

Use the following information to answer the next question.

Processes

I Neutralization
II Dehydration
III Dilution
IV Titration

7. A cafeteria worker spilled some liquid drain cleaner while trying to unclog a drain. The drain cleaner contained concentrated sodium hydroxide ($NaOH_{(aq)}$). The processes that would be **most** useful in treating this spill are labelled

A. I and III
B. I and IV
C. II and III
D. II and IV

8. In some cafeterias, plexiglass acts as a barrier between food and bacteria. Which of the following structures performs a similar function in the human body?

A. Skin
B. Antibodies
C. Macrophages
D. Killer (cytotoxic) T cells

9. When customers enter a dimly lit cafeteria from the bright sunlight, their eyes have to adjust to the difference in light intensity. The adjustment of their eyes involves an increased reliance on the

A. rods and a decrease in the size of the pupil
B. rods and an increase in the size of the pupil
C. cones and a decrease in the size of the pupil
D. cones and an increase in the size of the pupil

Most of society's current energy needs are met at the expense of the environment and result in the depletion of non-renewable resources. Many environmentalists suggest that we must reduce our energy consumption and consider the impact of using alternate sources of energy.

Use the following information to answer the next question.

Some Potential Environmental Concerns Associated with Energy Technologies

1 Release of radioactive material
2 Release of hazardous materials used in the production of photovoltaic cells
3 Water level changes affecting local ecological systems
4 Dissolved substances released into the hydrosphere and atmosphere

Numerical Response

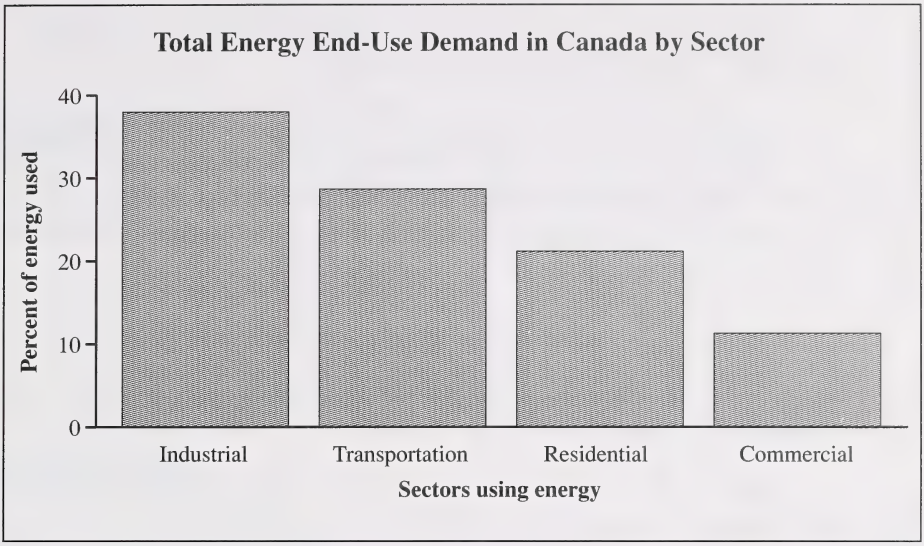
2. Match the environmental concern with the energy source that it relates to. Use each number only once.

Solar energy _____ (Record your answer in the first column on the answer sheet.)
Tidal energy _____ (Record your answer in the second column on the answer sheet.)
Nuclear energy _____ (Record your answer in the third column on the answer sheet.)
Geothermal energy _____ (Record your answer in the fourth column on the answer sheet.)

10. The **most feasible** way to **reduce** current world energy **consumption** would be to

A. develop more alternate energy sources
B. shut down high-energy-demand sectors
C. become more efficient in our use of energy
D. stop developing nations from increasing their energy demand

Use the following information to answer the next question.



11. The percentage of energy resources devoted to transportation **and** residential sectors is about

A. 50%
B. 60%
C. 70%
D. 80%

Use the following information to answer the next question.

Energy Technologies

1 Fission reactor
2 Hydroelectric dam
3 Tidal dam
4 Geothermal plant

12. Which of the technologies listed above use gravitational force to generate electrical energy?

A. Technologies 1 and 3
B. Technologies 1 and 4
C. Technologies 2 and 3
D. Technologies 2 and 4

13. Certain crops may be grown for the production of biomass. Photosynthesis occurs during the growth of the crop and is followed by combustion of the crop products to release energy. Which of the following statements provides an accurate comparison of combustion with photosynthesis?

A. Combustion and photosynthesis have similar reaction rates.
B. Combustion requires energy, and photosynthesis releases energy.
C. Combustion requires oxygen, and photosynthesis requires carbon dioxide.
D. Combustion and photosynthesis both produce carbon dioxide and release energy.

14. Which of the following energy sources provides the greatest amount of energy per kilogram of fuel used?

A. Coal
B. Biomass
C. Uranium
D. Natural gas

Use the following information to answer the next two questions.

A windfarm in Alberta produces an average of 20 MW of electrical power.

Numerical Response

3. If 1W is equal to 1 J/s, how much energy would be produced by one of these farms in one day?

Answer: _____ _•_ _____ $\times 10^{12}$ J

(Record your answer to two digits on the answer sheet.)

Numerical Response

4. The city of Calgary requires an average of 860 MW of electrical power. How many windfarms of this size would be needed to supply Calgary's electrical energy needs?

Answer: _____ windfarms

(Record your answer to two digits on the answer sheet.)

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15. Thermal pollution is a risk associated with all of the following energy sources **except**

A. coal
B. tides
C. methane
D. uranium

16. Two major environmental concerns associated with coal-fired generating stations are

A. acid deposition and ground-level ozone
B. ground-level ozone and hazardous wastes
C. the greenhouse effect and acid deposition
D. hazardous wastes and the greenhouse effect

17. One reason that coal is used as an energy source is that

A. it is non-polluting
B. it is a renewable resource
C. mining coal has little effect on the environment
D. it contains a great deal of chemical potential energy

18. Listed in the order in which they occur, the energy conversions in a coal-fired generating plant are

A. chemical → mechanical → thermal → electrical
B. chemical → thermal → mechanical → electrical
C. thermal → mechanical → chemical → electrical
D. thermal → chemical → mechanical → electrical

19. The power generating station that is **most** similar in design and operation to a coal-burning power plant is a

A. tidal power station
B. wind power station
C. nuclear power station
D. hydroelectric power station

Numerical Response

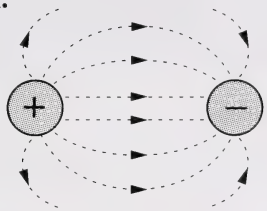
5. Electrostatic separators are used to clean particles from the smokestacks in coal- or tire-fueled power plants. A separator uses an electrical potential difference of 4.26×10^4 V between charged plates and develops an electric field strength of 50 000 V/m. What is the distance between the plates?

Answer: _____ _____ • _____ _____ $\times 10^{-1}$ m

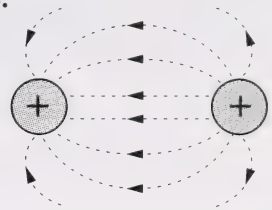
(Record your answer to three digits on the answer sheet.)

20. Which of the following diagrams represents electrostatic field lines?

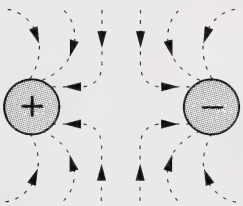
A.



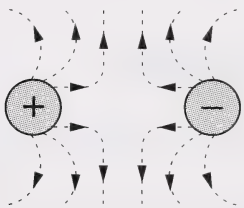
B.



C.



D.



Use the following information to answer the next two questions.

The high voltages in transmission lines must be stepped down for end use by consumers. A transformer steps down the voltage from 4 400 V to 220 V.

21. The ratio of primary turns to secondary turns in this transformer is

A. 1 : 20
B. 20 : 1
C. 1 : 5
D. 5 : 1

Numerical Response

6. If the current in the primary coil is 0.540 A, then what is the current in the secondary coil?

Answer: _____ A

(Record your answer to three digits on the answer sheet.)

22. Electric energy is **most efficiently** transmitted long distances using

A. low voltage, low resistance, and low current
B. high voltage, low resistance, and low current
C. low voltage, high resistance, and high current
D. high voltage, high resistance, and high current

Two environmental scientists monitored ultraviolet radiation levels and acid deposition in Northern Alberta.

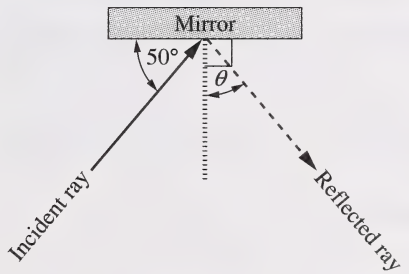
23. To find a route to a lake, the scientists used a topographic map and a compass. A compass is influenced **mainly** by Earth's

A. electric field
B. magnetic field
C. gravitational field
D. electromagnetic field

Use the following information to answer the next question.

One scientist used a mirror to signal the other scientist, as shown below.

Signalling Mirror



24. In the diagram above, angle θ is

A. 10°
B. 40°
C. 50°
D. 90°

25. One scientist had a deeply tanned face, which is typical of people who work outdoors. Tanning is due to the effects of

A. X-rays
B. gamma radiation
C. visible light rays
D. ultraviolet radiation

26. The wavelength of radiation reaching Earth's surface that has increased as a result of the thinning of the ozone layer is

A. 10^{4} m
B. 10^{-2} m
C. 10^{-4} m
D. 10^{-8} m

Use the following information to answer the next question.

Reactions Representing Destruction and Formation of Ozone in the Upper Atmosphere

Reaction I $O_{3(g)} \xrightarrow{\mathbf{1}} \underline{\mathbf{2}} + O_{2(g)}$

Reaction II $\underline{\mathbf{3}} + O_{(g)} \rightarrow \underline{\mathbf{4}}$ + thermal energy

Numerical Response

7. Ozone levels can be determined indirectly by monitoring ultraviolet radiation levels. Match the numbers in the reactions above with the parts of the equations listed below.

$O_{(g)}$	_____	(Record your answer in the first column on the answer sheet.)
$O_{2(g)}$	_____	(Record your answer in the second column on the answer sheet.)
$O_{3(g)}$	_____	(Record your answer in the third column on the answer sheet.)
Ultraviolet radiation	_____	(Record your answer in the fourth column on the answer sheet.)

27. The pollutants believed to be responsible for ozone depletion are

A. dioxins
B. phosphates
C. heavy metals
D. chlorinated hydrocarbons

28. One of the scientists monitored acid deposition by using a pH meter. She determined the pH of a sample of lake water to be 5.21. The hydronium ion concentration in this sample would be

A. 6.2×10^{-6} mol/L
B. 2.1×10^{-5} mol/L
C. 7.2×10^{-1} mol/L
D. 1.6×10^{5} mol/L

29. The scientist used indicators to confirm the pH of 5.21. The two indicators that were yellow after being added to the sample were

A. phenolphthalein and phenol red
B. methyl orange and indigo carmine
C. methyl orange and bromothymol blue
D. bromothymol blue and phenolphthalein

Drosphila melanogaster is a species of fruit fly commonly used in genetic research.

Use the following information to answer the next two questions.

Cross Involving a Lethal Allele

Some mutations are so disruptive to an organism that they cause death. These mutations produce lethal alleles.

Non-lethal dominant allele – L Lethal recessive allele – l

Cross – $X^LX^l \times X^LY$

Numerical Response

8. What is the predicted percentage of offspring from this cross that will die because of this lethal allele?

Answer: _____%

(Record your answer as a percentage on the answer sheet.)

30. The Punnett square that depicts the above cross, where the allele is X-linked, is

A.

	X^L	Y
X^L	X^LX^L	X^LY
X^l	X^LX^l	X^lY

B.

	X	Y	*L*
X	XX	XY	X*L*
X	XX	XY	X*L*
L	X*L*	Y*L*	*LL*
l	X*l*	Y*l*	*Ll*

C.

	X^LY	X^LY
X^LX^l	$X^LX^lX^LY$	$X^LX^lX^LY$
X^LX^l	$X^LX^LX^lY$	$X^LX^LX^lY$

D.

	X	Y	*L*	*l*
X	XX	XY	X*L*	X*l*
X	XX	XY	X*L*	X*l*
L	X*L*	Y*L*	*LL*	*Ll*
l	X*l*	Y*l*	*Ll*	*ll*

31. The occurrence of lethal alleles in fruit flies can be increased by irradiating them with ultraviolet rays that have a frequency of 1.15×10^{15} Hz. The segment of the fruit fly chromosome that is affected by the irradiation is very small and amounts to **one-half** the length of one of these ultraviolet wavelengths. The length of this segment is

A. 1.30×10^{-7} m
B. 2.61×10^{-7} m
C. 1.92×10^{6} m
D. 3.83×10^{6} m

Use the following information to answer the next question.

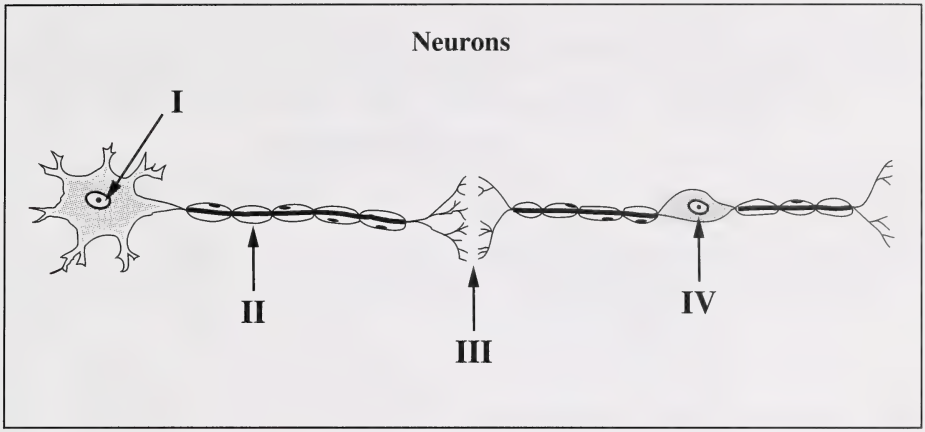
Production of Diethyl Ether

$$2\ C_2H_5OH_{(l)} \rightarrow C_2H_5OC_2H_{5(l)} + H_2O_{(l)}$$

32. Diethyl ether is used to anesthetize the fruit flies so that they do not fly away during examination. In the production of diethyl ether, the **reactant** is

A. ethanal
B. ethanol
C. ethanone
D. ethanoic acid

Use the following information to answer the next question.



33. Diethyl ether produces generalized depression of the central nervous system. It acts at the neural synapses in the brain and spinal cord. In the diagram above, the synapse is labelled

A. I
B. II
C. III
D. IV

Use the following information to answer the next two questions.

An experiment was conducted in which fruit flies were irradiated with a variety of wavelengths to test what effects the irradiation would have on the number of offspring they produced. The following data were obtained.

Fruit Fly Offspring

Type of Irradiation	Average Number of Offspring per Fly
Visible light irradiation	404.4
Infrared irradiation	404.4
X-ray irradiation	160.0
Gamma irradiation	57.1

34. In this experiment, the responding variable is the

A. type of irradiation
B. number of mutations
C. amount of irradiation
D. number of offspring per fly

Use the following additional information to answer the next question.

A Comparison of DNA Sequences

Gene strand from fruit flies irradiated with visible light: CAG ATT

Gene strand from fruit flies irradiated with gamma rays: CAT ATT

35. Researchers studied and compared the base sequence from the same region of DNA strands taken from fruit flies irradiated with different wavelengths. A reasonable hypothesis for this study is that gamma irradiation causes

A. segregation
B. nondisjunction
C. a point mutation
D. independent assortment

---

36. Gamma rays differ from visible light. Which of the following statements correctly compares the characteristics of these two regions of the electromagnetic spectrum?

A. Gamma rays have less energy than visible light has.
B. The velocity of gamma rays is greater than the velocity of visible light.
C. The frequency of gamma rays is greater than the frequency of visible light.
D. The wavelength of gamma rays is longer than the wavelength of visible light.

Doctors use their knowledge of science when treating their patients.

37. A patient punctured his foot by stepping on a rusty nail. He went to his doctor to receive a vaccination against the tetanus bacteria. The vaccination

A. killed the tetanus bacteria
B. destroyed tetanus antigens
C. destroyed tetanus antibodies
D. stimulated antibody production

38. Some white blood cells engulf foreign particles. This process is called

A. diffusion
B. phagocytosis
C. active transport
D. passive transport

39. A victim from a car accident was bleeding from a leg wound. This blood loss would result in

A. a decrease in blood pressure, which would be compensated for by dilation of the arterioles

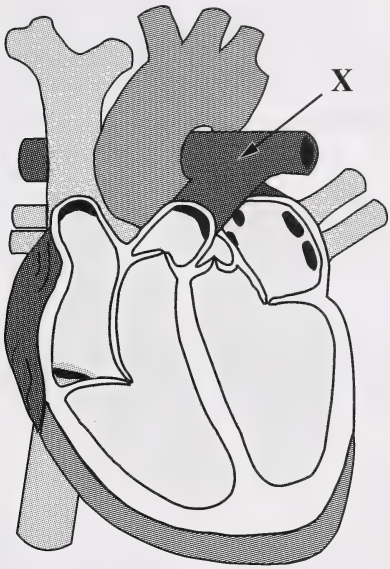
B. an increase in blood pressure, which would be compensated for by dilation of the arterioles

C. a decrease in blood pressure, which would be compensated for by constriction of the arterioles

D. an increase in blood pressure, which would be compensated for by constriction of the arterioles

Use the following information to answer the next question.

Human Heart



40. The structure labelled **X** is the

A. aorta
B. vena cava
C. pulmonary vein
D. pulmonary artery

Use the following information to answer the next question.

The following blood cell counts were made using blood samples from four patients.

Sample	Ratio of Red Blood Cells to White Blood Cells RBC : WBC
I	7 000 : 1
II	3 000 : 1
III	7 500 : 1
IV	10 000 : 1

41. Sample I was taken from a healthy individual. Blood exhibiting evidence of a bacterial infection was most **likely** contained in

A. sample II only
B. sample IV only
C. samples II and III only
D. samples III and IV only

Use the following information to answer the next question.

Functions of Eye Structures

1 Changes shape to focus light
2 Changes diameter of opening to eye
3 Converts light energy to nerve impulses
4 Carries nerve impulses to brain

Numerical Response

9. Match the number of the function with the structures listed below.

Iris _____ (Record your answer in the first column on the answer sheet.)
Lens _____ (Record your answer in the second column on the answer sheet.)
Optic nerve _____ (Record your answer in the third column on the answer sheet.)
Retina _____ (Record your answer in the fourth column on the answer sheet.)

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42. A doctor warned a patient about working with solvents in areas with poor ventilation. Kidneys can be damaged by organic solvents such as $CCl_{4(l)}$. During the manufacture of this compound, its hydrogen atoms were replaced with chlorine atoms. The name of this solvent is

A. tetrachlorocarbide
B. tetrachloromethane
C. tetracarbon chloride
D. tetracarbon chlorine

The study of space continues with the construction of space stations and with the launch of new space probes.

Use the following information to answer the next question.

Celestial Terms

1 Galaxy
2 Planet
3 Solar System
4 Universe

Numerical Response

10. When the above terms are arranged in order of smallest to largest, the order is _____, _____, _____, _____.
(smallest) **(largest)**

(Record your four-digit answer on the answer sheet.)

Numerical Response

11. The following reaction represents a nuclear change that occurs in stars.

$$\mathbf{A}^{2}\mathrm{H} + {}_{1}^{2}\mathrm{H} \rightarrow \mathbf{C}^{\mathbf{B}}\mathrm{He} + \mathbf{D}^{1}\mathrm{n}$$

Replace the letters given above with the numbers that would balance the equation.

A _____ (Record your answer in the first column on the answer sheet.)
B _____ (Record your answer in the second column on the answer sheet.)
C _____ (Record your answer in the third column on the answer sheet.)
D _____ (Record your answer in the fourth column on the answer sheet.)

43. A space probe was launched to perform a surface study of Venus. The probe's average orbital radius (distance from the centre of Venus) was 6.79×10^6 m. The mass of Venus is 4.88×10^{24} kg. The average gravitational field strength of Venus at this distance is

A. 7.06 N/kg
B. 7.06×10^6 N/kg
C. 4.79×10^7 N/kg
D. 4.79×10^{10} N/kg

Numerical Response

12. A camera on a space station has 2.40 A flowing through it. The current is generated by a 6.10 V solar panel. The resistance of the camera is _____ Ω.

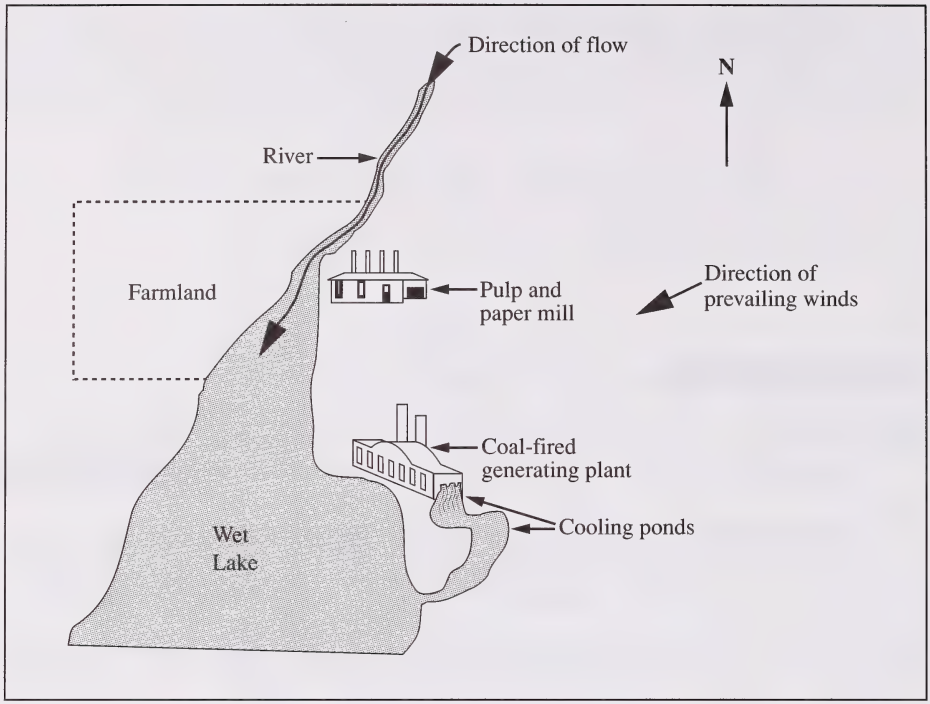
(Record your answer to three digits on the answer sheet.)

44. The risk posed by X-ray radiation in space can be rated as

A. low because of its low frequency
B. high because of its low frequency
C. low because of its high frequency
D. high because of its high frequency

The written-response questions begin on the next page.

Use the following information to answer the next question.



Written Response – 12 marks

1. Assume that you have been hired by the government as an environmental consultant to report on the water quality of Wet Lake.

The following industries are located close to the lake:

- a coal-fired generating plant
- a mixed farming (grain, cattle) area
- a pulp and paper mill

Describe the environmental problems that may be present in the lake because of **each** of the nearby activities. Describe some actions that could be taken to improve the water quality of the lake. Outline a procedure to test for **one** of the pollutants that may be present.

Use the following information to answer the next question.

In his book *Inventing the Future*, David Suzuki states that

"...there is no such thing as a problem-free technology. However [beneficial], technology always has a cost."

Written Response – 12 marks

2. There are numerous examples of how technological innovations have had detrimental side effects that eventually may have outweighed their benefits.

Explain the concern that Dr. Suzuki has expressed by selecting **one** technology from the list below. Analyze it in terms of its **benefits** and **risks**. Be specific by using scientific vocabulary, equations, or diagrams when appropriate. Present your opinion of how this technology should be used in the future, giving scientific explanations and reasons for your opinions.

Technologies:
- pesticides
- nuclear reactors
- genetic manipulation or engineering
- internal combustion engine (e.g., automobile)

You have now completed the examination. If you have time, you may wish to check your answers.

References

WR2 Suzuki, David. 1991. *Inventing the Future*. Toronto: Stoddard Publishing Co. Limited.

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Science 30

January 1998

Name

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